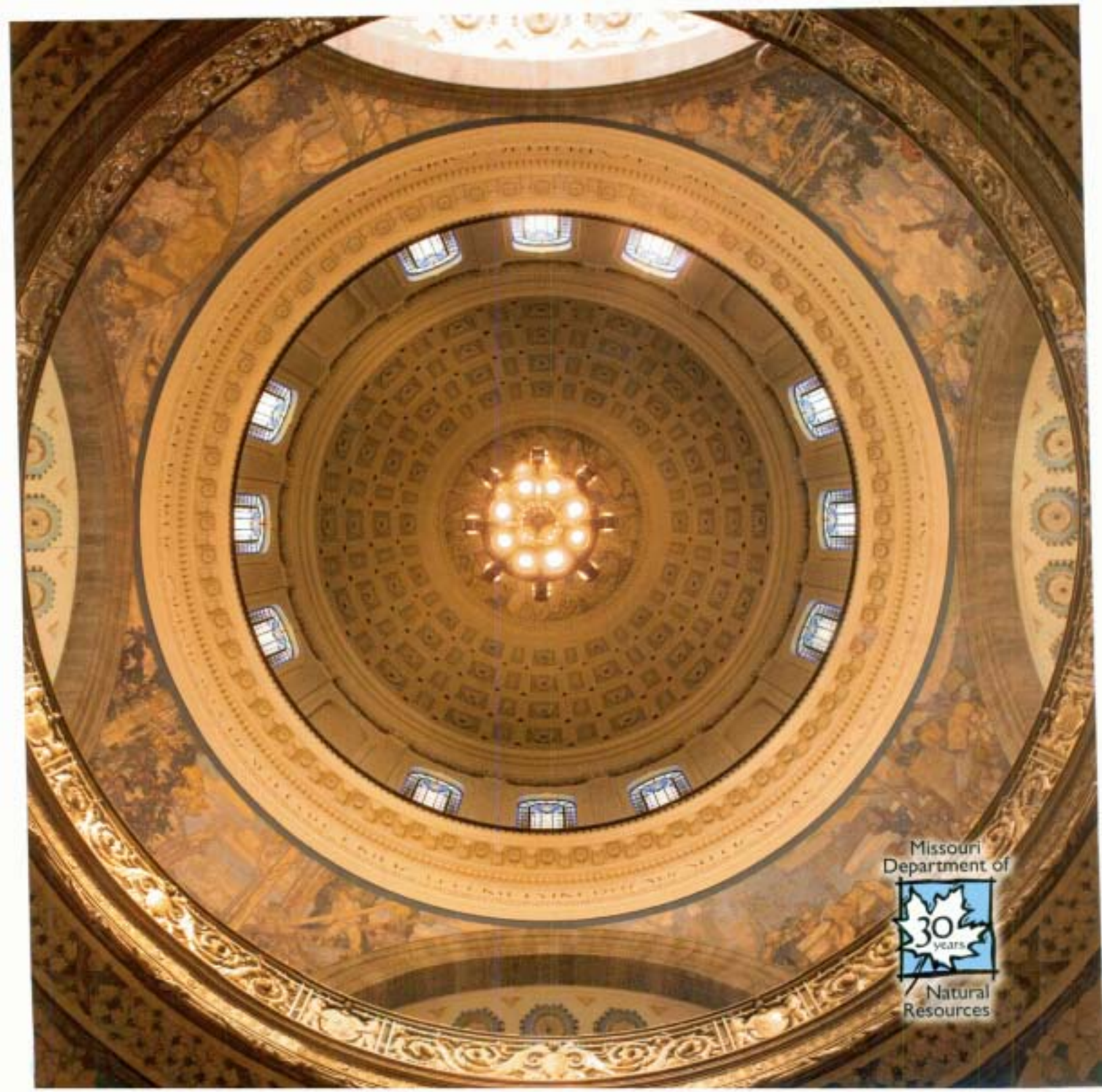
MISSOURI resources

FA 2004 • Volume 21 • Number ti



Director's Comment

Another legislative session has passed, and Gov. Bob Holden recently signed several pieces of resulting legislation into law. Particularly important to Missouri's resources is a group of four environmental bills that will have a significant impact on the way we do business.

Those of you visiting Missouri's parks and trails this summer and fall will be interested to know that this package includes a law that will encourage the development of walking and bicycling trails by protecting landowners whose property adjoins state-designated, county or municipal trails from civil liability. This law will have a significant impact on our department's Division of State Parks, as it will support their effort to complete Katy Trail State Park. This law also will aid local efforts throughout Missouri to develop city and county parks and promote green space.

Many of you also have closely followed our fee bills. As you probably know, time ran out to renew our Waste Tire Fee in the legislature during the 2004 session. However, two other important fee bills were extended and signed into law by Gov. Holden. Senate Bill 1040 extended the Hazardous Waste fee used for funding the safe collection and proper disposal of hazardous waste. This fee also helps fund our state's Superfund cleanups, with help from federal funding. The current Hazardous Waste Fee was set to expire Jan. 1, 2005. The new law extends this until June 30, 2006.

Gov. Holden also signed into law a bill that extends the Solid Waste Fee, which enables our department to manage the reduction, the reuse, the recycling and the safe disposal of solid waste and to identify and prosecute illegal dumpers. The bill also raises the minimum funds allocated to solid waste districts, which will help areas of the state that lack proper waste disposal and processing facilities. Both of these fees are critical to our department's ability to protect Missouri's air, land and water quality.

The Environmental Improvement and Energy Resources Authority's Market Development Program, while reduced by this legislation, will continue to foster the development of recycling markets to the extent resources are available. Markets for recyclables are an important component in the management of solid waste and to recycling's role in economic development for the state of Missouri.

Another bill signed into law moves regulatory authority for underground storage tanks from the Clean Water Commission to the Hazardous Waste Management Commission, which we believe is better equipped to handle this important responsibility. We will be working with both these commissions to make this transition.

Finally, the governor signed into law a bill that promotes more thorough blood-lead level testing for children at highest risk of lead poisoning in Missouri. The new law brings the state's language on lead testing into line with federal language on this issue.

We have greatly appreciated the continued partnerships with so many citizens and organizations all across Missouri. Attaining legislative priorities such as these is critical to the continued environmental health of our state.

We need that spirit of cooperation in the coming months as the parks-&-soils sales tax, which funds various payments for soil conservation practices and supports our stare park system, comes up for reauthorization by you, the voters of Missouri.

Steve Mahfood

Missouri Department of Natural Resources

MISSOURI resources

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Mission Statement
The mission of the Department of Natural Resources is to preserve, protect, restore and enhance Missouri's natural, cultural and energy resources and to inspire their enjoyment and responsible use for present and future generations.

"Integrity and excellence in all we do"

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printed on recycled paper

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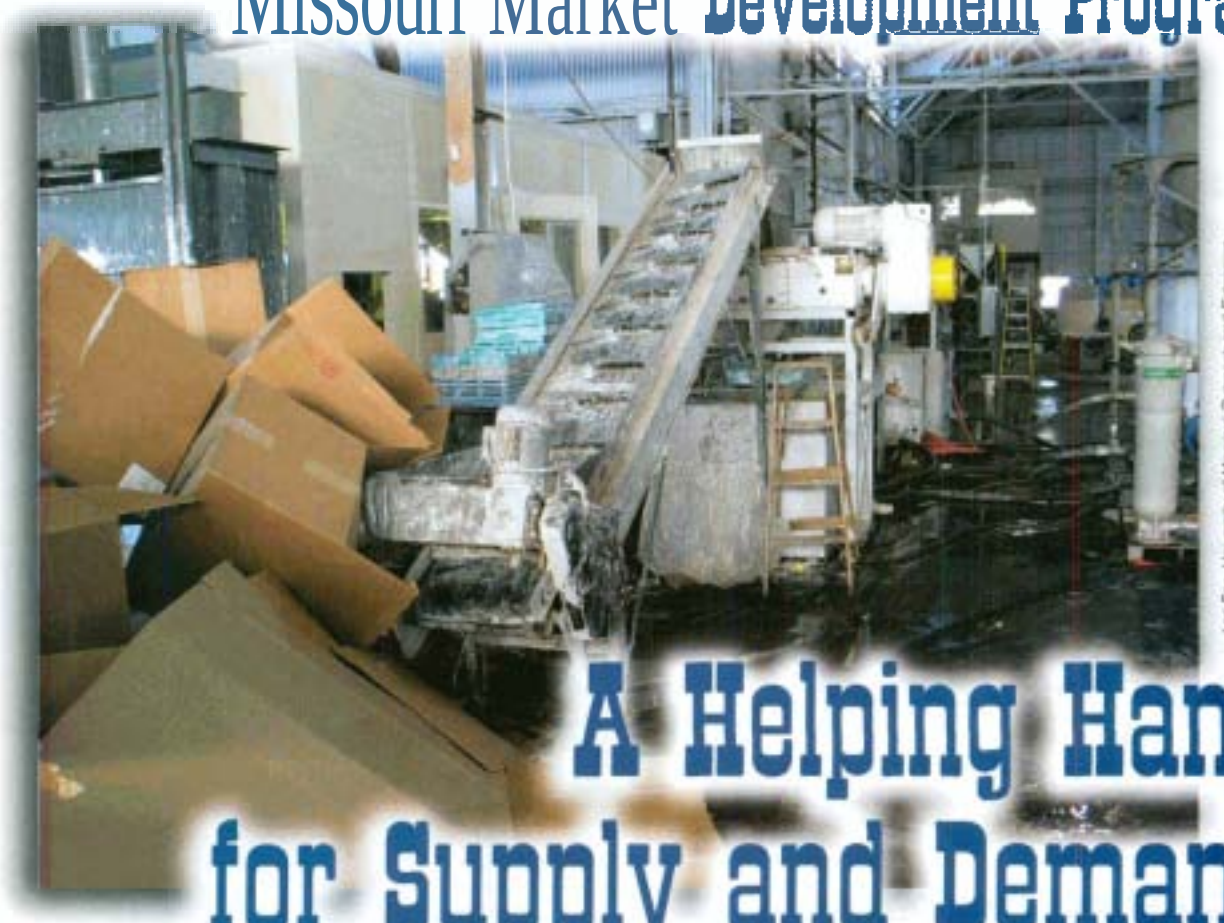
All photos by Scott Myers

Above right: Sandy Creek Covered Bridge, near Hillsboro in Jefferson County, is one of only four remaining covered bridges in the state.
Above: Fall trees turn from green to red along the banks of the Missouri River in Moniteau County.
FRONT COVER: A view of the Capitol dome from the rotunda is one of the many sites that greet visitors to the Capitol Museum.
BACK COVER: 75 million gallons of water drained in a matter of days when a sinkhole opened in Lake Chesterfield in St. Louis County.
Cover *photos by Scott Myers*

Missouri Market Development Program



Lee Fox, University of Missouri Outreach and Extension

A Helping Hand for Supply and Demand

by Kristin Allan

Sheldon Chesky can get a little excited discussing crumbling roadways. It's not that the Washington, Mo. business owner enjoys dodging potholes – it's just an enthusiasm stemming from his development of technologies that enable the recovery and reuse of deteriorated asphalt. When BioSpan Technologies Inc. determined that old pavements and road millings, along with waste tires and dock foam, could be reprocessed into a new paving material. the Environmental Improvement and Energy Resources Authority's (EIERA) Missouri Market Development Program was there to help.

The EIERA is a quasi-governmental agency that serves as the financing arm of the Missouri Department of Natural Resources, issuing nearly $5 billion in low-cost pollution and State Revolving Fund bonds over the years. In 1990, Senate Bill 530 authorized EIERA to establish the Missouri Market Development Program to encourage the development of markets for recovered materials.

Since that time, the program has worked on the demand side of the recycling loop. The program provides assistance to manufacturers who are located in, or wish to locate in, Missouri, and who use, or would like to use recyclables. By working to redirect waste to serve as raw materials for industry, these efforts provide a number of important environmental and economic benefits. including the creation of Missouri jobs. The Missouri Market Development Program is housed in the EIERA in order to bridge economic development and environmental interests.

"We are using innovative patented and patent-pending technologies to reclaim and recycle what we once considered to be non-reactive solid waste that would have been with us for several generations," said Chesky.

Most state and local highway departments use hot asphalt blends in making pavements. The asphalt eventually breaks down and is removed and ground into a uniform size called road millings. These millings have little, if any, use as a pavement resurfacing material and are accumulated in piles throughout the state. The BioSpan Technologies Inc. process is formulated to reactivate the millings without weakening the emulsion. The new product can be applied and used with conventional equipment, is safe for worker use and is environmentally friendly. Chesky noted that EIERA assistance is helping BioSpan commercialize its technologies and in the process, create seven new full-time

jobs. It also provides state, county and municipal entities with a new pavement technology that will result in tremendous cost savings.

Across the state, another Missouri company is finding good business in recycling both products and their containers. Tri-Rinse Inc. has been providing container cleaning, recovery and recycling services for more than 20 years. Over time, the company has found that the recovery of chemical products for re-introduction to the market has become an integral part of product management. With assistance from the Missouri Market Development Program, Tri-Rinse purchased equipment that will enable the company to return a product to the marketplace for reformulation or repackaging and at the same time recover the container and associated packaging components for recycling.

"By increasing productivity and reducing our customer costs, recovery becomes more economically advantageous than direct disposal," said Timothy P. Shocklee, Tri-Rinse Inc. chairman.

Tri-Rinse strives for complete recovery and recycling of all packaging components including the product, plastic containers, cardboard packaging and pallets. The equipment Tri-Rinse purchased with assistance from the Missouri Market Development Program provides an effective means of separating commercial products from plastic containers in order to rewver the products and recycle the containers. During the first two quarters of operation, in addition to product recovery, Tri-Rinse processed more than 90 tons of plastic, and Allowed for the recycling of 85 tom of cardboard and 50 tons of wood pallets.

During fiscal year 2004, the Missouri Market Development Program awarded financial assistance to 12 Missouri businesses. These businesses estimate that this assistance will help them divert more than 160,000 tons of waste from Missouri landfills each year, leverage more than $2 million in additional investment, save nearly $5 million each year in avoided disposal costs and create 47 new full-time jobs.

Businesses can tum to the Market Development Program for services other than financial assistance. The program also offers a range of informational support and can often assist a business in converting from traditional feedstock to using recovered material, locating recycled-content feedstock or promoting a recycled-content product. The Missouri Market Development Program's Missouri Recycled Products Directory is updated annually and features recycled-content products that are made in or distributed in Missouri. The directory is available on the Web at [www.dnr.mo.gov/eiera/assetts/product%20directory.pdf] or by calling the program at (573) 751-4919.

Through a partnership with the Missouri Enterprise Business Assistance Center, the Missouri Market Development Program also works directly with Missouri manufacturers to overcome technical barriers to increasing the use of recovered materials. Technical assistance is available in customized programs in such areas as plant layout, product feasibility, market research and product design and development.

Developing and maintaining markets for recovered materials is essential to closing the recycling loop. Markets for recyclables help ensure that recycling will bolster economic development in Missouri, improve its environment, conserve resources, create jobs and lengthen the lives of Missouri landfills.

Kristin Allan is director of the department's Missouri Market Development Program.

Lee Fox, UMC Outreach and Extension photo

Lee Fox, UMC Outreach and Extension photo

DNR photo by Brad Myers

(Opposite page) Equipment purchased with the assistance of the Missouri Market Development Program allows Tri-Rinse Inc. of St. Louis to recover and recycle chemical products. (Top) Timothy Shocklee of Tri-Rinse and author Kristin Allan discuss the chemical recovery process used at Tri-Rinse. (Center) Biospan Inc. uses a pub mill to mix its product with asphalt millings. (Bottom) Sheldon Chesky's company, Biospan, developed a process for turning the millings into new paving material.

Bill photo by Rick Anderson

Rediscovering the Wind

by Rick Anderson

What do rural landowners, civic leaders and utility officials have in common? They are striving to determine if Missouri's wind resource can once again make a useful contribution to economic well being and environmental quality by meeting part of our energy needs. Any discussion of wind resources in Missouri should begin where it started – with the late 19th-century landowners of the Great Plains.

Windmills for Water

During the late 1800s, ranchers and pioneers moving onto North America's Great Plains used windmills to assure a reliable supply of water on lands that, at least seasonally, were otherwise too dry to live on.. During the first half of the 1900s, many of these windmills were allowed to fall into disrepair as rural communities gained access to electrical service. As the new century begins, many rural landowners are rediscovering the potential of the winds to help meet the current and future energy needs of rural communities.!

Living near the top of a hill in northwest Missouri, Bill Slaughter has no doubt that his land gets a lot of wind. Like many other landowners, Bill has wanted to put the wind to work on his farm. On a December morning in 2003, with the help of some of his friends and neighbors, he took the first step by installing a wind energy research tower at the highest spot in his alfalfa field.

The 20-meter tower, along with a wind speed sensor and electronic data logger, are on loan, at no cost. from the Department of Natural Resources' Energy Center Anemometer Loan Project.

"Up here the wind is always pushing us wound. This tower will tell us just how strong these winds are and if we can put them to work," said Slaughter.

Slaughter is not alone in his interest in harnessing the power of the wind. This tower is one of ten such units on loan throughout the state. The equipment on the tower will measure and record the wind speed. Using wind energy analysis software, the Energy Center will be able to provide the landowners with a detailed wind energy assessment for the conditions 20 'meters above ground level at the site of the tower. The assessments will estimate the energy they could generate with a wind turbine and what part it could play in meeting their goals. "I don't know if I use enough electricity to make it pay and if it comes when I need it," Slaughter explained,

Civic Leaders Show Support

Developing Missouri's renewable energy potential has attracted the attention of individuals and organizations interested in a variety of public goals.

"We're very interested in promoting and advocating all forms of renewable energy, but wind appears to be the most available and affordable source," said Win Colwill, energy chair of the League of Women Voters of Missouri. "The League is supporting state legislation that will encourage the development and use of renewable energy statewide. I think the central issue for many members is the health benefit. Wind is a clean source that doesn't degrade air quality," she added.

Colwill's interest in advocating wind energy has a local connection too. "The League's Columbia chapter is supporting a proposal for the city's power supply to include some renewable energy. Developing domestic energy sources helps the economy as well as the environment," she said.

Acknowledging the increased attention being paid to Missouri's renewable energy potential, in 2003 the department contracted for the development of updated wind resource maps, with financial assistance from the U.S. Department of Energy.

"We're pleased to be able to make these new wind maps available," said Anita Randolph, director of the Department of Natural Resources' Energy Center. "The maps can be used by utilities and property owners to help locate the most practical sites for using wind turbines to generate electricity." The updated maps predict the wind speeds likely to be encountered at four different distances above ground level: 30, 50, 70 and 100 meters. "At most locations, wind speed and thus the energy in the wind increases at greater distance from the ground," Randolph explained.

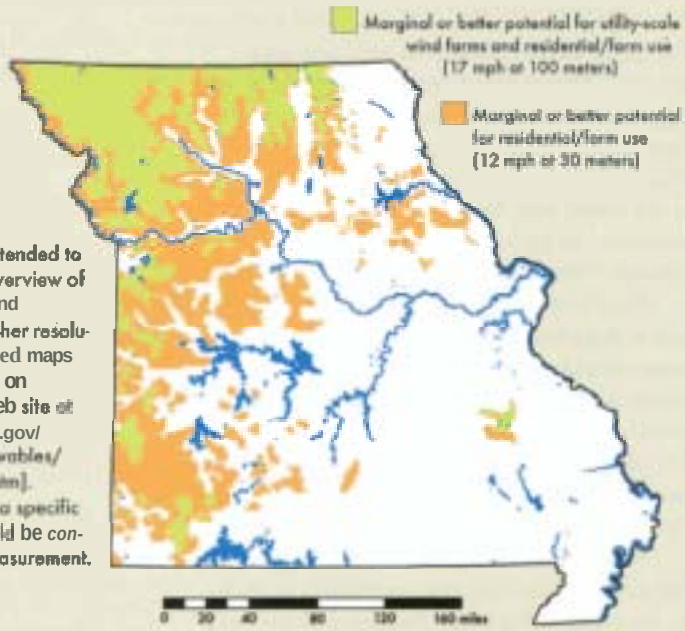
Wind turbines are made in a variety of sizes. A turbine between one and ten kilowatts could provide some of the electrical needs of a home or farm. Typically these smaller, customer-owned turbines would be on towers between 80 and 120 feet tall. The map of wind resources at 30 meters would help inform the siting of such a turbine.

Other potential uses of wind energy need maps detailing the conditions at higher elevations. Turbines designed to provide electricity for sale at wholesale rates to a utility company would typically be much larger, and would be placed on a much taller tower to make use of the greater wind power available at a greater distance from the ground. The latest utility-scale turbines are being installed on towers up to 90 meters tall. With rotor blades as long as 40 meters, the tips of the blades, when rotat-

DNR photo by Scott Myers

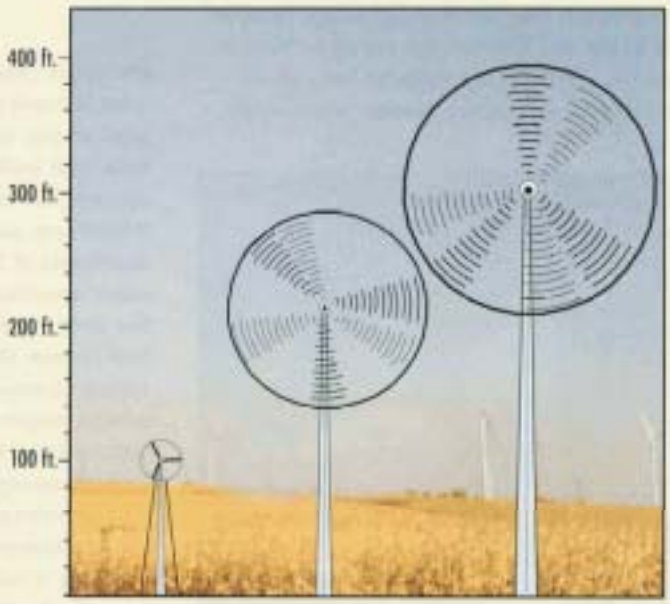
(Previous page) The Midwest is home to many new wind energy projects. Illinois' first utility scale development, the Mendota Hills Wind Farm, Just 80 miles southwest of Chicago, became operational in November 2003. Installed on 213-foot towers, the 63 turbines have a combined capacity of 50.4 megawatts. The wind farm is expected to produce enough energy to power 15,000 homes.
(Left) A one-year wind energy study is needed to assess the feasibility of a wind turbine. A no-cost equipment loan from the Missouri Anemometer Loan Project includes a 66-foot tower, instruments and an electronic data logger. Landowners participate in the installation of the tower and periodic replacement of the electronic data plug.

Wind Energy Potential



This map is intended to provide an overview of the state's wind resource. Higher resolution wind speed maps are available on MoDNR's Web site at [www.dnr.mo.gov/energy/renewables/windenergy.htm]. Estimates for a specific location should be confirmed by measurement.

Small vs. Utility-scale Turbines



	Residential / Farm Unit	1999-2001 Utility Scale (wind farm)	Current Utility Scale (wind farm)
Hub Height	80-120 feet	215 feet	300 feet
Turbine Capacity	10 kilowatts	660 kilowatts	1,500 kilowatts
Swept Area (rotor diameter)	23 feet	155 feet	230 feet
Approximate Cost	$30,000 to $35,000	$700,000	$1,500,000

Source: American Wind Energy Association

ing, can harness wind power between 50 and 130 meters above ground level. A wind-energy generator of that size could have a rated capacity of 1.500 kilowatts (1.5 megawatts). capable of producing 150 to 1,500 times more power than smaller systems suited to use on individual farms or houses.

Missouri Utilities Test Energy Center Project

Installation of utility-scale wind turbines has grown rapidly in recent years. For example, installed generation capacity in the United States at the end of 2003 totaled 6,374 megawatts, a 36 percent increase over the capacity installed one year earlier, (Annually, a one-megawatt turbine generates about as much electricity as is used by 240 to 300 households.) While there are no utility scale turbiies in Missouri, utilities in the state are beginning to look into the state's wind energy potential.

The community of Odessa, located 33 miles east of Kansas City and situated on high ground along Interstate 70, is one of several municipally owned electric providers participating in the Missouri Anemometer Loan Project.

"Odessa is interested in new sources of power supply. The city is determined to explore alternate sources of electric power," explained Wade Sanders, city administrator for the City of Odessa,

Missouri's investor-owned utilities have also taken steps to incorporate wind energy in their operations. In 2001, Aquila Incorporated (then known as Utilicorp), parent of the Missouri Public Service Company, contracted with FPL Energy, Juno Beach, Fla., to purchase all the electricity from a 110 megawatt wind farm in Montezuma. Kan. during the first 10 years it is in service. The wind farm has 165 turbines.

Anticipating customer interest in wind power, municipally owned Springfield City Utilities (CU) has taken several steps to evaluate how to respond to the apparent interest. In 2001, CU launched a green power purchase program known as WindCurrent. This program allows interested citizens to voluntarily pay a surcharge of $5 toward the utility's cost of purchasing power from a wind farm located in Kansas.

With the addition of a 10-kilowatt turbine on a 90-foot tower during 2003, CU became the first utility to purchase and operate a turbine in Missouri as part of its

power supply. Smaller than the turbines typically used for utility-scale, the CU turbine was installed primarily to study its performance and to expose Springfield citizens to wind technology. Recognizing that energy yield from a wind energy system is closely associated with the wind resource at a given location, CU is also participating in the Missouri Anemometer Loan Project. The department has installed 20-meter wind energy research towers at two other sites on CU property to help the utility determine if there is a Springfield-area site where wind resources might be more promising.

"Consistent with the interim wind map, the initial data from the Springfield towers suggests that the wind resource at 20 to 30 meters above ground level may not be sufficient to produce financially competitive wholesale power at these two sites," Randolph said. "We recommend getting a detailed wind resource assessment of a particular site as a prudent first step to guide wind energy investment decisions."

More recently, in March 2004 Aquila Incorporated and Ameren Services Company agreed to join the Missouri Energy Center to support a study of wind energy patterns in northern Missouri. The study proposal calls for the installation of wind speed instruments on existing communication towers at three levels: 50, 100 and, where possible, 150 meters.

"Missouri is rediscovering that using the wind is a three-way win. It can provide a domestic source of energy, stimulate Missouri's economy and reduce the air pollution emissions that degrade the environment," Randolph noted.

For more information, access the following online resource from the Missouri Energy Center: [http://www.dnr.mo.gov/energy/renewables/wind-energy.htm] and the U.S. Department of Energy's "Wind Powering America" at [http://www.eere.energy.gov/windpoweringamerica].

Rick Anderson is an energy policy analyst for the department's Energy Center, an office of the Outreach and Assistance Center.

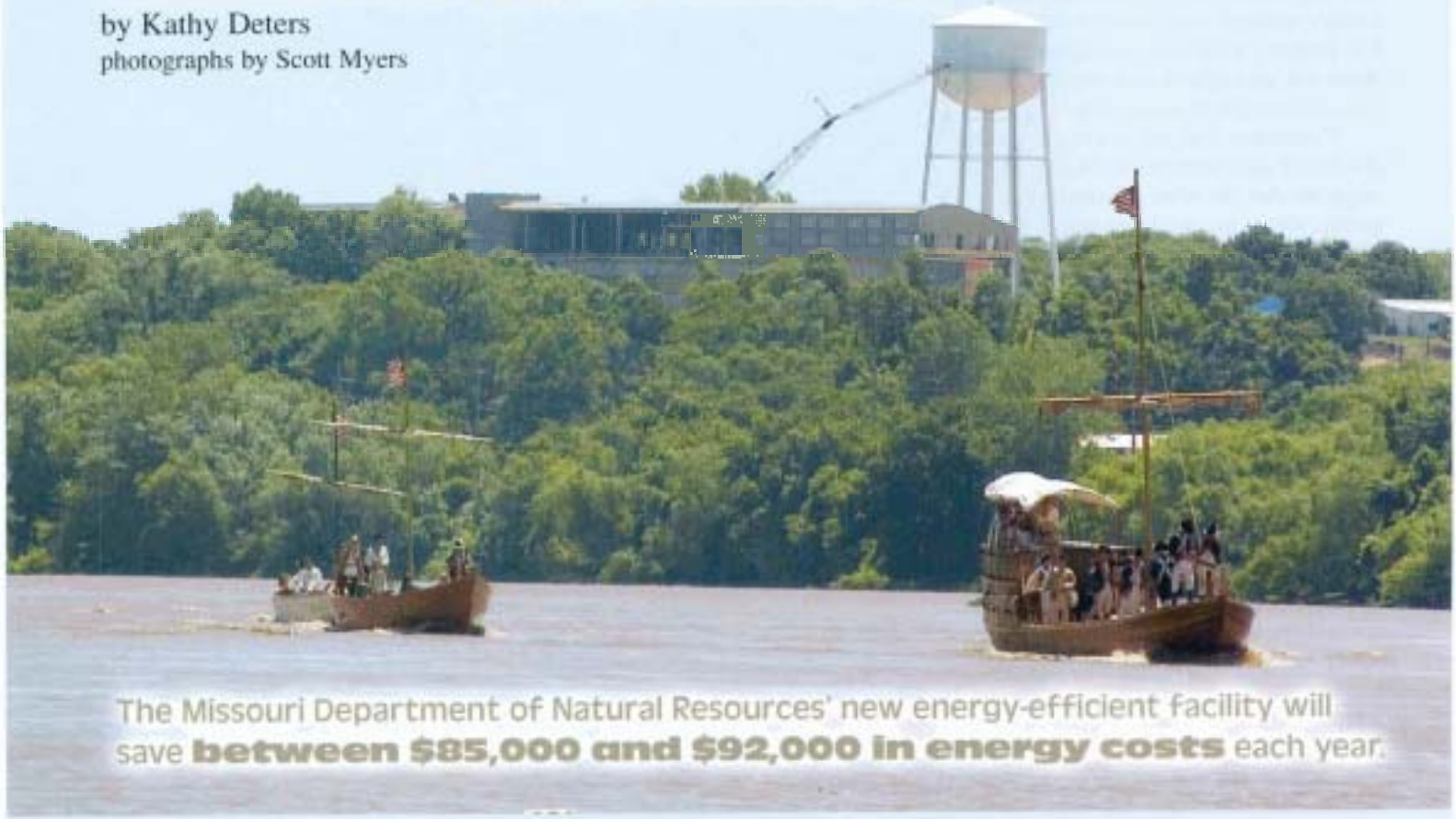
Two old water-pumping windmills stand unused near Auxvasse in Callaway County. Windmills used for pumping water, no longer operational and often in disrepair, are a common sight in rural Missouri.

DNR photo by Scott Myers

Green Savings

Lewis and Clark State Office Building

by Kathy Deters
photographs by Scott Myers



The Missouri Department of Natural Resources' new energy-efficient facility will save **between $85,000 and $92,000 in energy costs** each year.

In 1992, the State of Missouri, through the Missouri Department of Natural Resources and U.S. Department of Energy, published the most comprehensive study of the state's energy resources and plans aver completed. The Missouri Statewide Energy Study was underpinned with the reality that energy use in Missouri was heavily vested in outside sources. Energy planing needed to be based on both an increased use of in-state sources, and a decrease in its overall use.

In order to save money and utilize existing, available office spaces, the department's central staff, over time, had been dispersed all across Jefferson City in various rented offices. Few were within a quick commute of each other and many were in obscure locations off main thoroughfares. This was not only difficult for department staff, it was worse for anyone trying to do business with them. Soon, the cost to both fiscal and energy efficiency became difficult to justify.

Nine years after the State Energy Study was released, it was obvious that the department needed to consolidate central operations in a new facility. It also was clear that the energy efficiencies and green building technologies outlined in the State Energy Plan must be heeded. Shrinking financial resources also dictated that every nickel was going to count. It was time to prove that "going green" didn't have to break the bank.

To ensure the building would minimize energy use, the state sought Leadership in Energy & Environmental Design

(LEED™) certification for this new construction. LEED™ certification, administered by the U.S. Green Building Council, rates projects based on five criteria: site sustainability, energy and atmosphere, indoor environmental quality, material and resources, and water efficiency.

Designers from BNIM Architects in Kansas City, led by principals Bob Berkebile and Steve McDowell, incorporated several important elements into the design that will help the project achieve LEED™ certification. For example, the building faces into the southern path of the sun. Up to 90 percent of the building's occupants have natural sunlight, a technique known as daylighting. Light shelves and sun shades will perform two functions: reflect sunlight deeper into the building and shade external windows in the summer.

"As environmental stewards and recipients of Missouri revenue, we felt we had no choice but to construct a building that was smart, both environmentally and financially," said Jeff Staake, Department of Natural Resources deputy director. "This new building makes the most of Missouri's resources."

Officials at the department hope this building will encourage other state agencies to incorporate elements of sustainable design into new or current facilities as well. Gov. Bob Holden established a policy group to make recommendations on issues related to the state's energy use. In June 2003, the Governor's Energy Policy Council reported its finding.

Significant were the dramatic savings that could be generated by simply improving the energy efficiency of state buildings. According to the report, state agencies and universities spend about $78 million annually on energy. A ten percent reduction could save $7.8 million annually.

"We're proud of this project but we hope it won't be the last of this nature," said Dan Walker, who served as the department's coordinator for the project. "We hope this building will serve as tangible evidence that sustainable design can, and does, work ... new facilities can easily incorporate these elements into their new facilities, but many existing facilities can be retrofitted as well."

Energy software modeling of the designed electrical and mechanical systems in the Lewis and Clark building estimates between $85,000 and $92,000 per year in energy cost savings – essentially half that of most state buildings.

The new facility, which offers 120,000 square feet, will include staff from the Water Protection and Soil Conservation Division, the Water Resources Program, the Outreach and Assistance Center, the Division of Administrative Support and the director's office. More than 430 staff will begin moving into the building in late 2004.

In addition to its energy efficiency measures, rainwater from the mof is captured for flushing toilets while waterless urinals will improve water efficiency. The site's landscaping features native Missouri plants, which require less water.

The department also chose a location in line with a governor's directive to revitalize Missouri's urban cores. The building is part of the Jefferson City Correctional Center (JCCC) redevelopment project. It will serve as a linchpin between the JCCC redevelopment and a wooded tract east of the building site, which is planned for recreational opportunities.

"I like that the Office of Administration chose to name this new office building the Lewis and Clark State Office Building, because it will remind Missourians of the importance of being willing to venture into uncharted territories," said Steve Mahfood, director of the Missouri Department of Natural Resources. "Though the concept of sustainable design may still be unfamiliar to many of us, its environmental and economic benefits definitely make it something worth exploring."

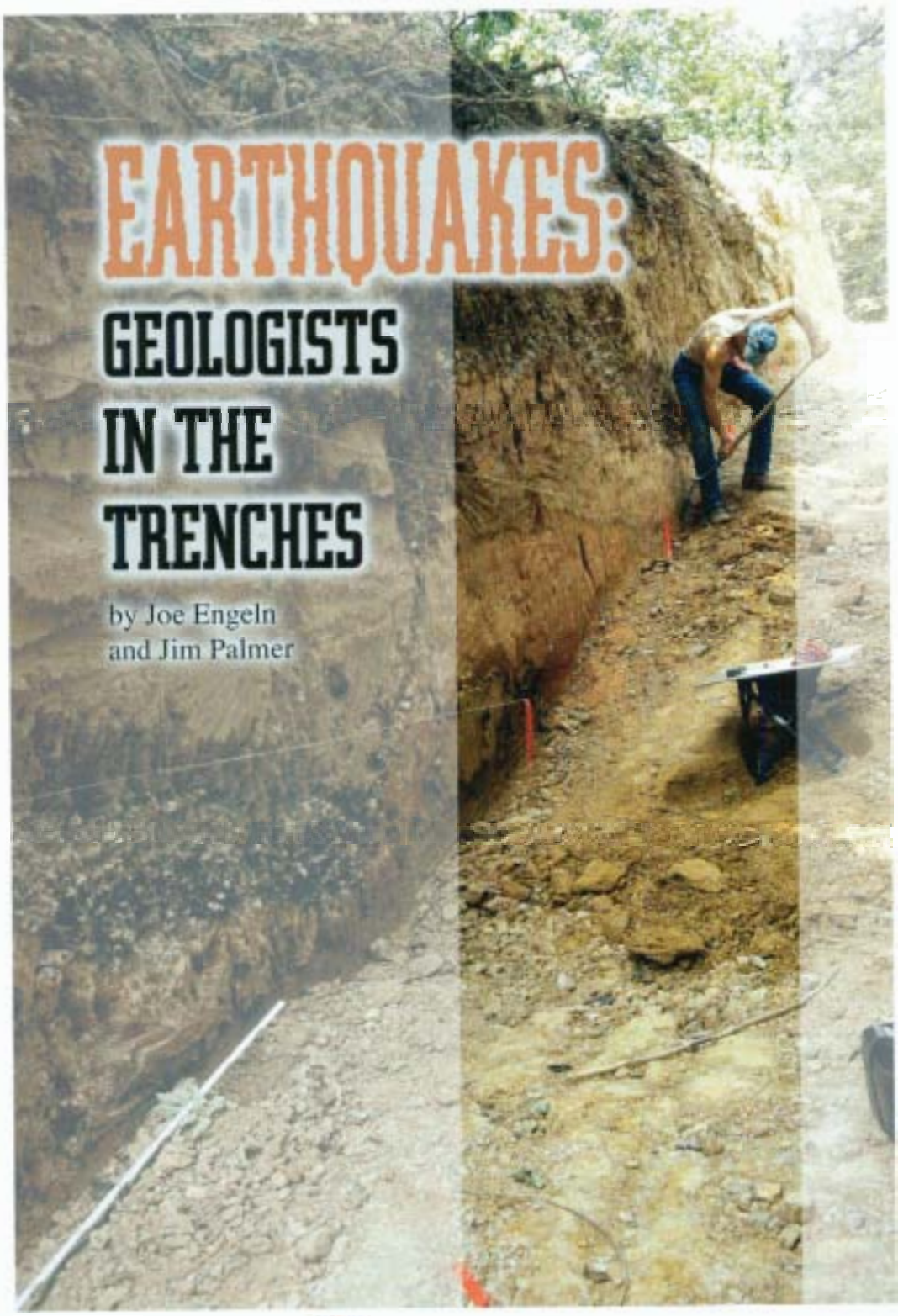
For more information on the Lewis and Clark State Office Building, call 1-800-361-4827.

Kathy Deters is a public information coordinator with the department's Outreach and Assistance Center.

(Opposite) The Discovery Expedition of St. Charles passes below the new Lewis and Clark State Office Building as it travels by Jefferson City during a reenactment of the original Lewis and Clark expedition. (Below) One of the energy-saving features of the Lewis and Clark State Office Building is the extensive use of daylighting. The design of Me building uses light shelves to bounce light inside whore it is spread into the interior with reflective panels.

EARTHQUAKES: GEOLOGISTS IN THE TRENCHES

by Joe Engeln and Jim Palmer



DNR

Many have similar images of a major earthquake – the ground shakes violently, buildings crumble, and people are killed. Some even have a rough idea of what intensity a quake must reach on the Richter Scale (see glossary on page 11 for definitions of italicized terms) in order to create damaging results. A magnitude 7.0 can be catastrophic, whereas a magnitude 3.0 is barely felt.

However, the amount of energy released during an earthquake is only one of many geological factors that determines how an area will be affected.

Two recent earthquakes illustrate this point. On Jan. 17, 1994 a magnitude 6.7 earthquake struck a heavily populated area in Northridge, Calif., causing moderate infrastructure damage and claiming 57 lives. Less than 10 years later, on Dec. 26,2003, another magnitude 6.7 earthquake struck Bam, Iran. This second quake killed 30,000 Iranian citizens and destroyed an incredible 85 percent of the city's infrastructure.

Why do earthquakes cause such differing levels of damage and loss of life? Geology, community awareness and preparedness appear to be major factors. The Department of Natural Resources' Geological Survey and Resource Assessment Division (GSRAD) works to help Missourians gain a better understanding of earthquake hazards.

Geologists with GSRAD study earthquakes to help define earthquake sources and produce detailed maps that illustrate earthquake hazards in particular areas of Missouri. The division also collects data to predict how surface and sub-surface soil materials will behave during an earthquake.

Some soils may actually intensify seismic waves. Solid bedrock, however, commonly resists strong shaking. Some soils and other loose materials are also subject to liquefaction during earthquakes.

WHY MISSOURI STUDIES EARTHQUAKES

During the winter of 1811-1812, a series of three very large and many smaller earthquakes jolted southeastern Missouri and parts of several adjoining states. These tremors were centered around the community of New Madrid, one of the earliest permanent settlements in the area. Very small "microearthquakes" still occur periodically along numerous faults in this area.

By geographically plotting the epicenters of these minor quakes, scientists have defined the extent of what is now called the New Madrid Seismic Zone (NMSZ). The zone stretches roughly from the southern tip of Illinois, through the Missouri Bootheel, and into northeastern Arkansas (see map on page 13).

Through historical accounts of the 1811-1812 earthquakes, we know the three major quakes were felt over an area of 2.5 million square miles. Church bells as far away as Washington, D.C. rang. The nearly 2,000 aftershocks that followed these monster quakes were felt up to 180 miles away from their epicenters. Because no instruments were present to record the earthquakes, their magnitude on the *Moment* Scale is not known, but these large events would cause significant damage if they were to occur again today.

WHAT CAUSED THE 1811-1812 EARTHQUAKES ALONG REELFOOT RIFT?

An earthquake is a release of energy along a zone of weakness or fault. The energy is released when the rocks on either side of the fault suddenly move or slip past each other. The 1811-1812 earthquakes were centered on deeply buried faults that are part of an ancient rift known as the Reelfoot Rift (see graphic on page 12). A rift is a valley that forms along faults due to stretching of the earth's crust.

The NMSZ differs from other regions with more frequent earthquakes, such as the San Andreas Fault in southern California, that are located along *tectonic* plate margins. In contrast, the NMSZ is a great distance from an active plate boundary. While the stretching that formed the rift has ceased, the NMSZ remains a focus of earthquake activity because of forces within the North American plate.

IDENTIFYING EARTHQUAKE SOURCES AND HAZARDS IN MISSOURI

Geologists with GSRAD, and others, have studied and mapped earthquake related features in soils that are as old as 75,000 years, finding evidence for multiple earthquake events in Missouri. This method of studying

(Opposite page) James D. Vaughn, retired GSRAD geologist, prepares a trench wall for mapping. String lines are used as reference points to map geologic features in surficial materials. The sails are shaved with hand tools, such as sharp shovels and hoes, to reveal details of structure and layers. (Below) The Old Quarry Trench, located in Benton Hills, Scott County, was dug in 1995-97. It exposed evidence of several faults. Dave Hoffman, a retired GSRAD geologist, is using a hoe to prepare the wall for mapping.

GLOSSARY OF EARTHQUAKE TERMS

EPICENTER: the point on the earth's surface directly over the point where the earthquake begins.

LIQUEFACTION: the flow of sandy, loose material, soil and water during an earthquake. This material usually flows upward through cracks to form sand blows.

MOMENT (MAGNITUDE) SCALE: measurement of the amount of energy released in an earthquake.

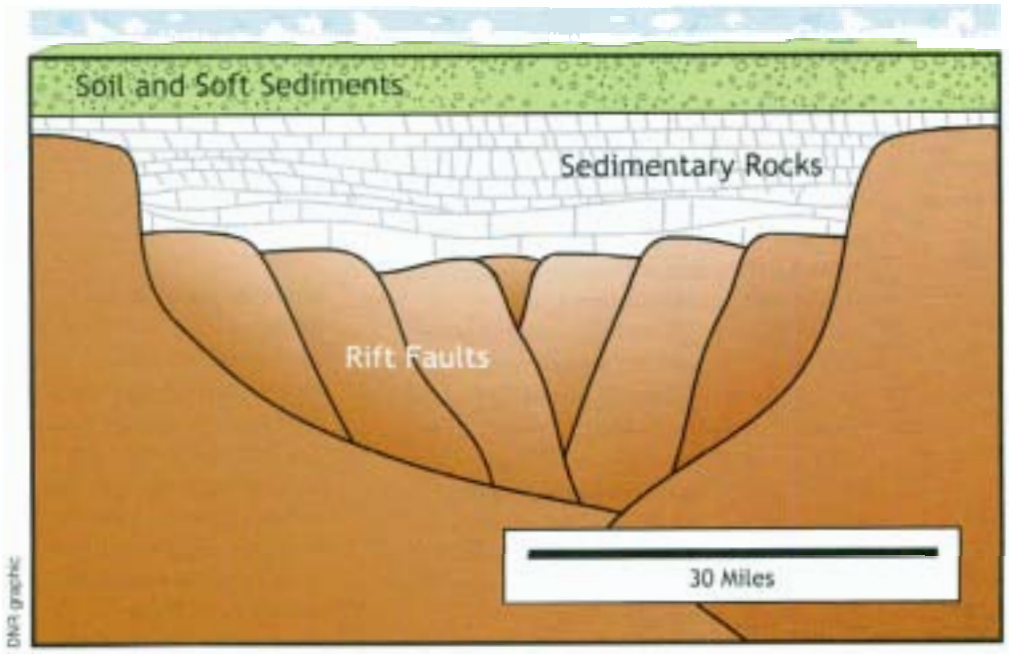
PALEOEARTHQUAKES: prehistoric earthquakes recognized by studying sediments and soils that have been disturbed by the earthquakes.

RICHTER SCALE: measurement of an earthquake's size bated on the height or amplitude of the seismic waves.

TECTONIC PLATES: a few large and many smaller blocks of the outer layers of the earth, the crust and upper mantle, that move relative to one another. Most earthquakes occur along the margins of the plates as a result of these movements.

DNR photo by Jim Palmer

Reelfoot Rift Cross Section



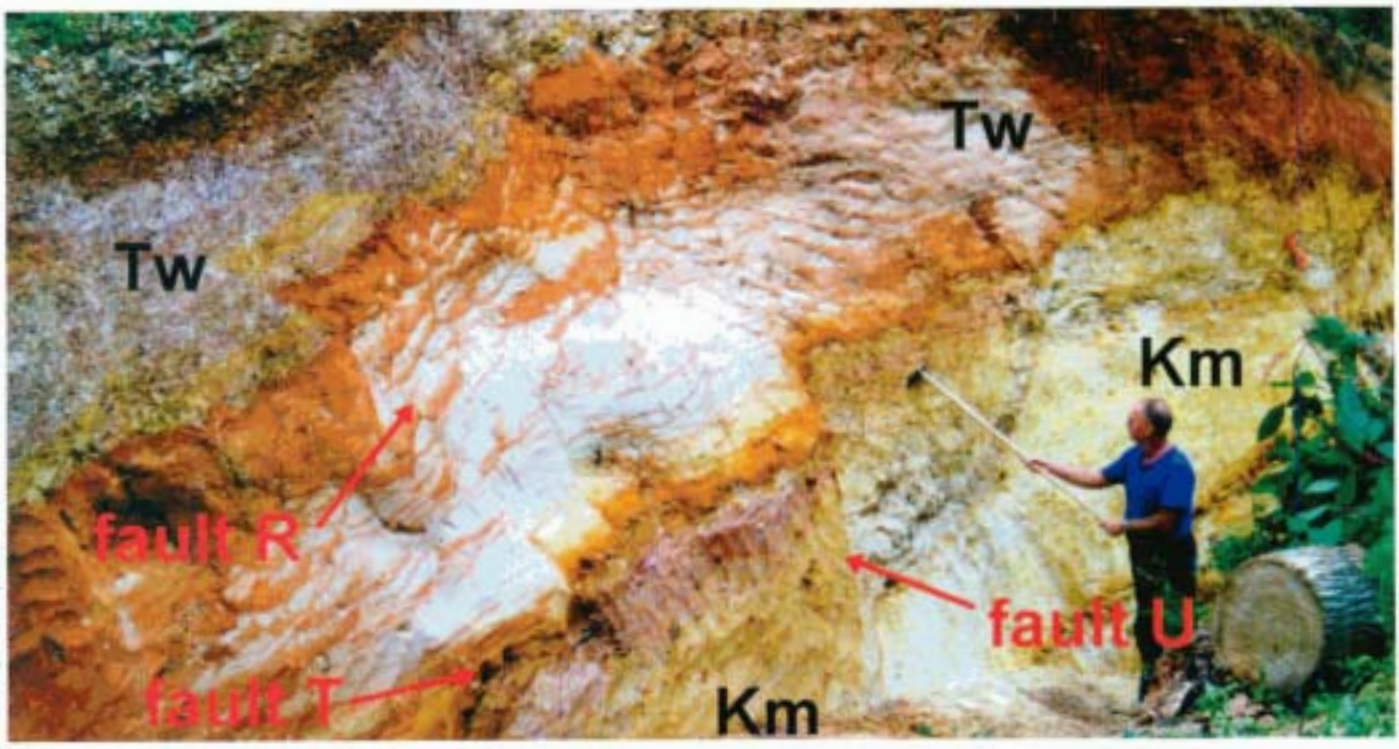
DNR graphic

old earthquakes is termed paleoseismology. Some of these features are outside the area that has the 1811-1812 liquefaction features or faulting. This means that these is evidence for seismogenic faults other than the most active parts of the NMSZ.

Geologists have found and mapped paleoliquefaction features that date between 22,750 and 590 years before the present in sediments located between Poplar Bluff and Dexter. This dating was based upon radiocarbon ages of the sediments bounding the structures. These features are a series sf buried sandblows and associated sand dikes that resulted from four separate paleoearthquakes. These anomalies suggest earthquakes of at least moderate magnitudes occurred outside the NMSZ.

Another *paleoearthquake* study used geologic mapping as a guide to find a series of faults near Commerce, Mo., 20 miles north of the NMSZ. Trench mapping found evidence for five surface fault rupture events. The oldest of these events was 75,000 years, while two were within the past 5,000- 6,000 years.

Together, the historic, seismological, and geologic data suggest an obvious conclusion: fault zones in the active area of the New Madrid region can produce large, destructive earthquakes. Not as obvious is the earthquake risk posed by fault zones in areas that have not had historic, damaging earthquakes. Therefore, the two cases described above represent possible earthquake source zones that would appear to occur outside of the NMSZ.



U.S. Geological Survey photo by Rich Harrison

NEW PROJECTS MAP OUT EXPECTATIONS ON WHERE, HOW TO BUILD

Geologic mapping provides the basic data needed to determine earthquake hazards. Both bedrock and surficial material types are important factors. Local shaking response to earthquake waves depends on the properties of soil types. Generally, locations that have thin, dense soils over hard bedrock are the least likely to experience extensive shaking in an earthquake, while areas that have soft and low density soils, and groundwater saturated sands can amplify shaking and liquefy.

Building designers consider this information at their site when determining the necessary foundation and building design, and appropriate construction methods.

To help Missourians, GSRAD has prepared a series of generalized maps for eastern Missouri that show areas of possible liquefaction. These generalized maps show the location of areas that have thick, sandy soils such as river valleys that could have liquefaction during a strong earthquake. More detailed and technical maps have been prepared for some other areas in southeast Missouri. These maps classify areas based on the physical property of soils to amplify shaking and may be used as a guide as to what could be expected during an earthquake.

ST. LOUIS GEOTECHNICAL DATABASE AND URBAN HAZARD MAPPING

Together, GSRAD, the Illinois Geological Survey, the United States Geological Survey(USGS) and the University of Missouri-Rolla are undertaking a five-year project to map earthquake hazards in the St. Louis metropolitan region. The St. Louis project includes collecting geotechnical soil-boring data that is available from other agencies and private sources.

Staff at GSRAD are responsible for collecting and creating the database for the Missouri portion of the project area, and preparing it to be used for mapping the properties of surficial materials. The geotechnical data will be used to produce maps that show potential liquefaction and the soil's amplification class at 1:24,000 map scales.

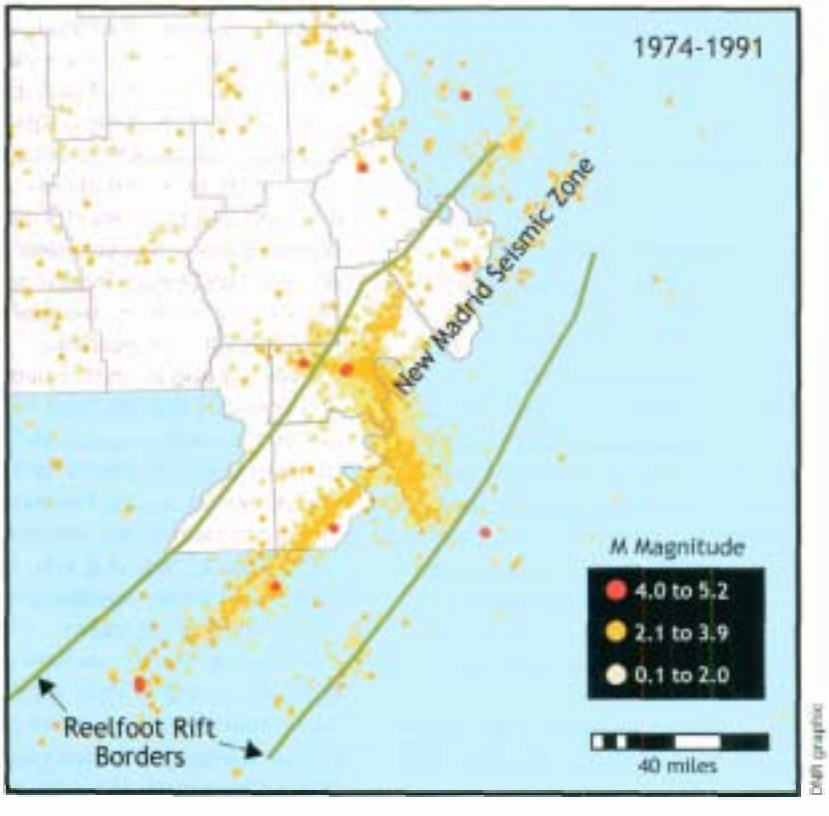
Such mapping provides an idea of expected conditions, but should be supplemented with site-specific data for building design purposes. Modem-day studies, technical identification, mapping and database projects such as these have made preparation possible. New lessons now can be learned from earthquakes that occurred many centuries ago. Modern, technical studies and data derived from previous earthquakes have demonstrated that building damage and loss of life can be minimized with appropriate knowledge and corresponding preparation.

The goal of GSRAD's work is to assure that appropriate data is collected to map earthquake hazards, produce information that the public may use to understand earthquake risk and provide the public with information necessary to plan accordingly. To that end, earthquakes need not always conjure up images of utter devastation and chaos. Missouri communities are being given the tools necessary to understand the risks and plan accordingly.

Joe Engeln is assistant to the department director for Science and Technology. Jim Palmer is a geologist with the department's Geological Survey and Resource Assessment Division.

(Opposite page bottom) The Upper Rainbow Trench in Benton Hills, Scott County, was created in 1995-97. Dave Hoffman, a retired GSRAD geologist, is shown preparing the trench for mapping by removing loose dirt from the trench wall. Layers labeled TW (Tertiary Wilcox Formation) include orange and white sand and pinkish clay. Layers labeled KM (Cretaceous McNairy Formation) are silty and micaceous-sand and silt. The three red fault labels represent specific fault lines that were mapped.

Southeast Missouri Earthquake Epicenters and Magnitudes



Learn More About Your Drinking Water

Missouri public water customers recently received information on the quality of their drinking water. The annual Consumer Confidence Reports are sent to consumers by July 1 each year, helping Missourians make practical, knowledgeable decisions about their health and environment. The reports describe the water sources used by the public water systems, identify any contaminants found during routine testing and provide general information on drinking water and health.

"The public has a right to make informed decisions regarding the water they consume," said Steve Mahfood, director of the Missouri Department of Natural Resources. "This report provides information much like what we've come to expect on our food labels."

To assist utilities in producing the reports, the Missouri Department of Natural Resources' Water Protection Program developed an informational packet containing a template and tips on developing an informative report and making it available to customers. The Consumer Confidence Reports also provide public water suppliers with an opportunity to explain how the community's drinking water supplies are protected and help build their relationship with customers.

All community water systems are required to produce and distribute a Consumer Confidence Report. These systems include cities, water districts, subdivisions, mobile home parks and other water systems serving at least 25 residents. A copy of the report is sent by mail, published in the local newspaper or posted at the water system's office, public buildings and the local library. Systems serving more than 10,000 people must deliver each customer a copy of the report and smaller systems may use one of the other delivery or notification options.

The Missouri Department of Natural Resources encourages the public to read their water system's Consumer Confidence Report and become better informed about their drinking water. Any citizen served by a community water system who does not receive a Consumer Confidence Report should call their water provider for one.

For more information, call the Department of Natural Resources at 1-800-361-4827 or (573) 751-5331.

Department Grant Helps Fund Stream Education

The Missouri Department of Natural Resources has awarded a $28,531 grant to the Missouri Department of Conservation for the Stream Educational Workshops and Product Development Project. This portion of the grant covers the first year of a four-year project totaling $68,105. The Missouri Department of Conservation will provide a match contribution of $116,870 over the life of the project, bringing the overall cost of the water quality project to $184,975.

The project will develop educational tools and products for use in workshops for volunteers and various government agencies that have the potential to impact streams. For instance, staff from the U.S. Army Corps of Engineers, urban land developers, Department of Transportation, county road and bridge crews, U.S. Fish and Wildlife Service, and volunteer groups like Missouri Stream Teams, could all benefit from learning how their activities impact the environment.

"We're trying to reach volunteers and agencies with the most direct contact with our water resources," said Stephen Mahfood director of the Department of Natural Resources. "They can make a real difference for our citizens by applying what they learn about stream dynamics towards protection and restoration techniques that they can use in their own projects." According to Mahfood, it takes a well-informed public to make good stream management decisions. *Educating people about the environment is the foundation we must continue to build on," said Mahfood. "Using our grant dollars to make this information available through workshops, on the Internet and via compact disc, will help us make a difference in our water protection efforts," he added.

The U.S. Environmental Protection Agency, Region 7, has provided partial funding for this project under Section 319 of the Clean Water Act. The department will administer the funds. For more information, contact John Knudsen with the department's Water Protection Program at 1-800-361-4827 or (573) 526-1386 or John Fantz, stream biologist with the Missouri Department of Conservation at (660) 530-5500.

For more information about the Water Protection Program, please visit [www.dnr.mo.gov/wpscd/wpcp].

Department Resumes Dam Inspections

The Water Resources Program staff engineers from the department's Geological Survey and Resource Assessment Division (GSRAD) in Rolla are once again inspecting state-regulated dams. Staff engineers will ensure these dams meet safety standards so they do not put people and infrastructure downstream of the structures at risk. Missouri has approximately 640 dams that must meet safety standards and 10-15 new dams are proposed each year.

During the budget process for fiscal year 2005, the Missouri General Assembly restored staff and funding to the Department of Natural Resources to resume inspections of state-regulated dams. Due to budget reductions last fiscal year, dam permits that came due on regulated dams between July 1,2003 and June 30,2004 had to be inspected by engineers hired at the expense of the dam owner.

Owners of dams regulated by the state have been notified by mail of the changes in the inspection program. The department will be glad to assist the dam owners during the transition process. The public is welcome to call

Landmark Agreement With Drey Family Offers Unique Backcountry Experience

Hikers will be able to experience the solitude and wildness of the Roger Pryor Pioneer Backcountry in southeast Missouri, thanks to an agreement between Leo and Kay Drey of St. Louis and the Missouri Department of Natural Resources.

Located mainly in Shannon County, the backcountry is a 61,000-acre portion of the Pioneer Forest, the state's largest privately owned forest. Through the agreement with the department, the Dreys have donated easements for trail corridors so hikers and backpackers can experience the backcountry.

Twenty-seven miles of trail currently exist in the backcountry. These include the 13-mile Blair Creek Section of the Ozark Trail, the 12-mile Brushy Creek Trail, and a two-mile Laxton Hollow Trail, which connects to the Ozark Trail. The area includes nearly 15 miles of frontage on the Current River. Bisecting much of the backcounty are portions of three tributary watersheds, the Big Creek, Brushy Creek and Blair Creek. Two designated natural areas are located within its borders. The Current River Natural Area is an outstanding site that contains impressive 400-year-old trees. The Pioneer Natural Area is adjacent to the Current River and contains old-growth eastern red cedar and hardwood trees.

The backcountry is named in honor of Roger Pryor, a leader and major supporter of wilderness protection in Missouri. The Department of Natural Resources will build additional trails and a trailhead in the future.

For more information and directions to the trailhead, contact Johnson's Shut-ins State Park at (573) 546-2450 or the Department of Natural Resources toll free at 1800-334-6946 (voice) or 1-800-379-24t9 (Telecom-munications Device for the Deaf). Information also is available by calling the Pioneer Forest at (573) 729-4641

the Water Resources Program at (573) 368-2175 or call the toll-free number at 1-800-361-4827 and ask for Jim Alexander or Bob Clay of the Water Resources Program in Rolla.

Geologic Hazard Drains 23-acre Lake Chesterfield

The Harbor is a prestigious lakeside community in west St. Louis County. In mid-June, the community's 23-acre centerpiece, Lake Chesterfield, had completely disappeared leaving in its wake a large pit of mud (see back cover photo of this issue), This startling phenomenon was caused by a sinkhole that had seemingly formed in a matter of days – the geologic equivalent of pulling the drain plug in a sink.

Geologists from the Geological Survey and Resource Assessment Division (GSRAD) immediately investigated the site. They took along an engineering geology map of St. Louis County, that had been prepared in 1991 by the Missouri Division of Geological Survey and Water Resources, the predecessor division of GSRAD. The map indicated that the area in which Lake Chesterfield is located is underlain by limestone bedrock that is considered a severe risk for the construction of small lakes due to excessive leakage and the possible formation of sinkholes.

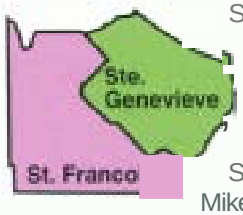
Reportedly, repairs of small sinkholes and excessive leakage had been made to the lake several times since it was built. Many years before, GSRAD staff also had noted that the creek immediately downstream of the lake is a losing (sinking) stream, and because of waste disposal issues in the area, the division conducted a water trace to determine where the water goes. The trace documented that water reappears downstream at Lewis Spring. The water that drained out of Lake Chesterfield probably followed the same path, which likely is a winding underground cave system that surfaces at Lewis Spring.

GSRAD provides the public with geologic maps of specific regions that provide details about bedrock, surficial materials and other geologic features. In some areas, such as the St. Louis area, this information has been converted into engineering units to assist community planners, developers and others. The division's publication, A Guidebook *for the Geologic and Hydrologic Evaluation of Small Lake Sites* in Missouri, also is useful for planning the construction of a lake.

Surficial materials mapping is helpful to developers, city planners, emergency responders and highway engineers. While such mapping cannot usually be used to answer site-specific questions, it does provide engineers and others with an idea of expected conditions and the need for further site investigation in some areas.

Surficial geology situations like the Lake Chesterfield sinkhole emphasize the importance of mapping both surficial materials and bedrock. Numerous maps and a wide variety of publications are available through GSRAD's publications desk at (573) 368-2125 or toll-free at 1-800-361-4827. A listing of the publications also is available on GSRAD's Web site at: [www.dnr.mo.gov/geology/adm/publications/pubshp.htm].

Southeast Missouri Boundary Issue Settled



Sweral years ago. St. Francois County Surveyor Terry Eflan sought the counsel of State Land Surveyor Mike Flowers of the Geological Survey and Resource Assessment's Land Survey Program. In question was the boundary line between Ste. Genevieve and St.

Francois counties. Running through same of the land first settled by Missouri pioneers, across pastures, cropland, cattle country and new subdivisions, this line plays a significant role in many issues. Its placement could change property rights, voting rights, road maintenance and tax assessments for those affected.

Originally surveyed in 1841, at a time when the tools of the surveyor's profession included a compass and a surveyor's chain, it was impossible to run a "direct line" for 20 miles over rugged terrain. Also, the boundary had become obliterated over time. As a result, the Ste. Genevieve and St. Francois County Commission called for a new survey in 1925 to retrace the 1841 line,

Today, technological advances in surveying have greatly improved the science. Using global positioning satellites (GPS), it now is possible to mark a "direct line" the full 20 miles. This makes the term "direct line" in the legal description confusing.

A direct line the full 20-mile length would differ from the line marked in 1925 by as much as 1,100 feet in some places. Correcting this could create numerous unforeseen problems. Over the years, a few property descriptions actually have called for the county line as a property boundary. Upon careful examination of the problem, both Effan and Ste. Genevieve County Surveyor Gerald Bader, the state surveyor, and the county commissioner, agreed that a direct line was not in the best interest of the landowners or the counties. As a result, Flowers wondered if surveyors should mark the line as described, or as surveyed. He felt it was clear that a change in the statute describing the line would be the best way to handle the situation.

In 2003, a bill was signed by Gov. Holden, describing the boundary between Ste. Genevieve and St. Francois as that line surveyed in 1925 by county surveyors representing both counties and approved by the county commissions. There was no wording that included the phrase "direct line." The passage of this law opened the way for a survey of the 20-mile section of line between the two counties.

The county surveyors recently completed a resurvey of the county boundary. It will be recorded In each county, the Land Survey Repository in Rolla and in the secretary of state's office. To learn more about land survey in Missouri, visit the Land Survey Program's Web pages at: [www.mo.gov/geology/lndsrv/lndsrvhp.htm].

Energy Loans tor 21 Projects Total $6.58 Million

Since the end of 2003, the Department of Natural Resources* Energy Center has granted $6,588,900 in low-interest energy loans to 21 public entities across Missouri. The Energy Loan Program helps public schools and local governments invest in energy-efficiency projects which save money that can be used for other expenditures and services.

"Investing in energy efficiency is the best way to help lower utility costs," said Anita Randolph, director of the Energy Center. "These loans pay for themselves through energy savings and allow districts to improve classroom conditions for students, save taxpayer money and redirect the savings toward the classroom."

The energy-efficiency upgrades generally are used for upgrading insulation, lighting, heating, air conditioning and windows.

The energy loan recipients and their loan amounts since December 2003 are: Ash Grove R-IV School District, $97,000; Blue Springs R-IV School District, $241,200; East Lynne 40 School District, $121,200; Halfway R-III School District, $65,600; Hardin-Central C-2 School District, $196,300; Hermitage R-IV School District, $82,800; Hickory County R-I School District, $87,500; Mehlville R-IX School District, $370,800; Metropolitan St. Louis Sewer District, $104,700; New Franklin R-I School District, $242,500; Newburg R-II School District, $241,900; Norborne R-VIII School District, $45,200; Osage County, $49,900; Park Hill School District, $4,100,000; Pierce City R-VI School District, $97,300; Plato R-V School District, $80,900; Richmond R-XVI School District, $34,800; Stockton R-I School District, $124,300; Walnut Grove R-V School District, $69,600; Weaubleau R-III School District, $78,200; and Wheatland R-II School District, $57,200.

Loans from the Energy Revolving Fund are not defined as debt so they do not count against a facility's debt limit. Therefore, they also do not require a public vote or bond.

Public schools, universities, city and county governments, public hospitals and water treatment plants are examples of eligible applicants, Since the program's Inception in 1989, more than $58 million in energy loans have been granted to Missouri applicants.

For more information, contact the department's Energy Center at (573) 751-3443 or toll-free at 1-800-361-4827.

EIERA Supports Greeting Card Program

The Environmental Improvement and Energy Resources Authority (EIERA), a financial arm of the Missouri Department of Natural Resources, provided a $1,000 scholarship to support the Environmental Greeting Card Program, which is sponsored by the 350-member Missouri Waste Control Coalition (MWCC).

The program committee received 660 card entries from 20 Missouri schools – the most since the program was established in 1995 by the MWCC. The purpose of the program is to encourage Missouri students, in grades 5 through 9, to design colorful, artistic cards that capture waste management themes and messages that promote environmental protection.

The first-place winner was Anna Kuklik, a seventh-grade student at Parkway Northeast Middle School near

environmental notes

Waste Tire Cleanups on Hold – Responsibilities Remain

In both 2003 and 2004, the 50-cent tire fee that had funded the cleanup of more than 12 million illegally dumped waste tires from Missouri's landscape was not renewed by the General Assembly. Most activity regarding waste tires by Missouri Department of Natural Resources staff has ceased and staff have been assigned to new jobs; however, laws that regulate the proper disposal of waste tires remain in effect.

There are 3.9 million tires remaining to be picked up in sites all across Missouri. The Department of Natural Resources estimates a million more have not yet been located. Each year Missouri motorists discard approximately 5 million waste tires. Some of these are resold as used tires. Most are recycled into fuel, new tires, rubber surfacing, hoses and rubber mats.

Until the tire fee is reinstated, the solid waste staff will oversee cleanup of as many waste tire piles as possible until all funds are spent. This is expected to be around Christmas 2004.

You can help by leaving your discarded tires with the dealer. Those who choose to keep their old tires should remember that each waste tire provides excellent breeding habitat for up to 1 million mosquitoes in a season. Diseases such as West Nile virus and various encephalitis strains pose a health threat to both animals and humans. Store old tires indoors or take steps to keep water from collecting in them.

For further information, please call the department at 1-800-361-4827 or the Solid Waste Management Program at (573) 751-5401.

Ladue in Franklin County. Kuklik received $100 and a printed supply of her award-winning greeting card. *Also,* her seventh-grade class, taught by Martha Bunch, received $100 as the "winning classroom." The second-place winner was Kevin Hunt, a student in Jackie Coskey's seventh-grade classroom at Republic Middle School in Republic, which is located about 20 miles west of Springfield. Hunt received $50. Third-place winner Charlene Maravilla received $25. She is a student in Sheryl Lamme's class at Partridge Elementary School in Waynesville.

The judges for the 2004 competition were Dolores Vermont, Chesterfield, committee chairperson and MWCC past president; Dale Behnen, Valley Park, MWCC president; Arlene Shaw, St. Louis, art director, Ladue School District; and Kenneth Seeney, Jefferson City, assistant to the director, EIERA, and MWCC past president For more information about the Environmental Greeting Card Program, contact Kenneth Seeney with EIERA at (573) 751-4919.

Report Will Detail State of Missouri's Environment

The Missouri Department of Natural Resources will release a report on the current state of Missouri's natural and cultural resources. The "State of Missouri's Environment: Trends, Challenges and Achievements," provides a detailed look at the quality of Missouri's air, land and water quality. Research continues to link a clean environment to the overall health of the citizens that use these resources.

Poor air quality, for example, has been shown to cause a variety of respiratory diseases, and impaired water quality not only poses a threat to the fish and wildlife it supports, but to citizens who may drink this water as well.

"Every Missouri citizen living in every corner of this state deserves safe water and clean air," Gov. Bob Holden said. "Unfortunately, this hasn't always been the case. In the past, families in our large urban areas, for example. have had to keep children with asthma inside during much of the summer due to poor air quality.

"Homeowners near lead smelters have been forced to move due to lead contamination ... . Those who once enjoyed taking a dip in the local creek now must consider run-off ... and other sources of pollution," Holden added.

The 2004 State of Missouri's Environment report details the significant progress that has been made in Missouri's environmental quality in recent years. It looks at the state's many triumphs, including significantly improved air quality in St. Louis and Kansas City and improvements in drinking and groundwater.

It also examines the many challenges that remain, such as the growing demand placed on water treatment and public drinking water systems, non-point source pollution, soil erosion and the loss of the waste tire fee. which funded cleanups of 12 million waste tires in illegal dumps.

"When considering the quality of Missouri's resources, we typically think of natural resources," said Steve Mahfood, director of the Missouri Department of Natural Resources. "But our cultural and historical resources play a significant role in Missouri as well, particularly for our economy. It also details the role that state parks and historic preservation have played in generating revenue in Missouri ... ."

The 2004 State of Missouri's Environment Report is geared toward businesses, community leaders, educators, legislators and the general public. The publication was with the printer at press time for Missouri Resources, but should be available in late fall. It will be accessible on the department's Web site at [www.dnr.mo.gov] or a free copy of the report can be obtained by calling 1-800-361-4827.

Department Wins National Award With MoDOT

A joint effort of the Department of Natural Resources and Missouri Department of Transportation (MoDOT) to reduce run-off from highway construction sites has received national recognition and an award from the American Association of State Highway and Transportation Officials (AASHTO).

The natural resources/transportation team was recognized as an Exemplary Partner by the (AASHTO) for streamlining the permitting process for the Department of Transportation and reducing the number of environmental notices of violation issued to MoDOT projects by Natural Resources inspectors. That number decreased from seven in fiscal year 2002 to four in FY 2004.

"Your work on improving our permitting process with the Department of Transportation is worthy of recognition on strictly its own merit," Department of Natural Resources Director Steve Mahkod told the department's team members. "Often, improving a working relationship is overlooked as a positive way to enhance environmental quality," he added.

Only seven of the applicants competing nationally this year received Exemplary Partner recognition, which is the group's highest level of team recognition. The MoDOT and Natural Resources team effort will be recognized at the AASHTO annual meeting in Philadelphia in September.

Solid Waste Fee Reallocated

Senate Bill 1040, passed during the 2004 legislative session, provides solid waste tonnage fees until Aug. 28, 2005, to enable the state to continue implementing solid waste management efforts. This includes permitting new landfills, expanding existing landfills, enforcement, and planning and distributing recycling and waste-diversion grants. The bill revises the allocation of the tonnage fee without raising it, and makes up for general revenue lost during the state's budget shortfall.

The bill also creates a joint committee appointed by the speaker of the house and president pro tern of the senate to study and recommend distribution of funding for the department's solid waste management activities. This interim committee will make a recommendation on restructuring the fees to the governor and the General Assembly by December 31, 2004.

For news releases on the Web, visit [www.dnr.mo.gov/newsrel]. For a complete listing of the department's upcoming meetings, hearings and events, visit the department's online calendar at [www.dnr.mo.gov/oac/calendar.htm].

Time Exposures

U.S. Army Corps of Engineers

When the Lewis and Clark expedition made its first trip through Missouri in 1804, the Missouri River was a wide, shallow river that meandered across the floodplain. Shifting channels and large snags made river travel treacherous. As early as 1819, the United States Congress recognized the importance of improving the Missouri River for navigation. This picture shows a crew of U.S. Army Corps of Engineers employees weaving a mat of willow trees near Huntsdale, Boone County, in March, 1900. Often these willow mats were layered with rock in an effort to keep the river from scouring either the bank, or in this case, a constructed dike. The dikes were employed to direct the river's flow toward a central channel and to protect the downstream bank from erosion.

Send your photo to "Time Exposures," c/o *Missouri Resources*, P.O. Box 176, Jefferson City, MO 65102-0176. All pictures will be returned via insured mail. Pre-1970 environmental and natural resource photos from Missouri will be considered. Please try to include the date and location of the picture, a brief description and any related historic details that might be of interest to our readers.

Camdenton Middle School

Young Volunteers Win National Award

Students at Camdenton Middle School received a national Take Pride in America award for their volunteer work at Ha Ha Tonka State Park. The 30 eighth-grade students volunteered their time to help remove undesirable cedar trees in a two-acre area where glade and savanna landscape is being restored.

The school was recognized in a ceremony in Washington, D.C. last year and attended by Nancy Masterson, superintendent at Ha Ha Tonka State Park – the person who nominated the school. First Lady Lori Hauser Holden also recognized teacher Lori Brock and the students in a ceremony at the school in Camdenton. Masterson presented Mrs. Holden with four walking sticks made from cedar trees removed during the project.

Nancy Masterson and First Lady Lori Hauser Holden with Camdenton Middle School eighth graders

Mrs. Holden noted that the school was involved in an effort to recognize local citizens called Hometown Heroes. "To me, you are the Hometown Heroes, and I hope you continue in your volunteer efforts," Mrs. Holden said. She also read an official letter from the governor commending the students on both their efforts on behalf of the park and winning the national award.

The students that received the award took part in the school's 2002 service learning day. Park staff had cut the trees previously and the students relocated the trees for loading and unloading. The cut trees were then used as fish habitat or employed to stop soil erosion and stabilize the adjacent Lake of the Ozarks shoreline. The removal of the trees allows more sunlight to penetrate to the forest floor, encouraging dormant prairie species to grow. Signs have been placed on a trail to educate the public about the project, which is adjacent to the trail. The one-half million people that visit Ha Ha Tonka State Park each year will be able to enjoy this unique landscape which once covered much of Missouri.

Take Pride in America is part of a national partnership, establishe by the U.S. Department of the Interior, that is designed to inspire a new generation of volunteers to improve their parks, refuges, recreation areas and cultural and historical sites. The school was one of only 15 organizations nationwide to receive the award and was one of only two schools to be recognized.

Besides the Camdenton Middle School students' efforts on behalf of the citizens of Missouri, the effort helped illustrate the importance of stewardship to our state park system. As future state park users, they will value the diverse and unique qualities of all our state parks, and hopefully share them with their children.

Michael Bradford

14-year-old Reports Polluted Creek

Michael Bradford

Michael Bradford, an eighth grade student at Center Middle School in south Kansas City, received a special "Citizen Salute* award from the Missouri Department of Natural Resources. Karl Fett, of the department's Kansas City Regional Office, made the presentation during Bradford's spring graduation ceremonies. Earlier in 2004, the 14-year-old Boy Scout was hiking along Boone Creek when he noticed that the water was discolored and full of sediment. "Michael didn't just shrug his shoulders and hope somebody else would take care of the problem,* said Fett during the graduation assembly attended by 1,200 students, parents and teachers. "He took it upon himself to track the pollution to its source: a blocked sewer main with sewage spilling out of the manhole." Bradford returned to his school and reported the situation to his science teacher, Ron Scott, who alerted city officials and the Department of Natural Resources.

Boone Creek snakes its way through Bradford's southern Kansas City area, and he knows the stream better than almost anyone. A recent Bay Scout trip to Nsw Mexico included a 50-mile hike in the desert mountains, so traversing the small, suburban stream is a challenge he is well-equipped to handle. Once, Bradford and a friend decided to follow the creek as far upstream as possible to determine where it originated. Boone Creek basically starts as a small city tributary fed by suburban watershed runoff. Bradford said the creek gathers steam after it exits a large concrete pipe a few miles upstream from his home. It is fed by storm sewers and an occasional wastewater sewer that overflows during rains. Bradford knew the usual condition of Boone Creek and describes it as, "... a beautiful area with a healthy ecosystem that provides water for deer and other animals that live there."

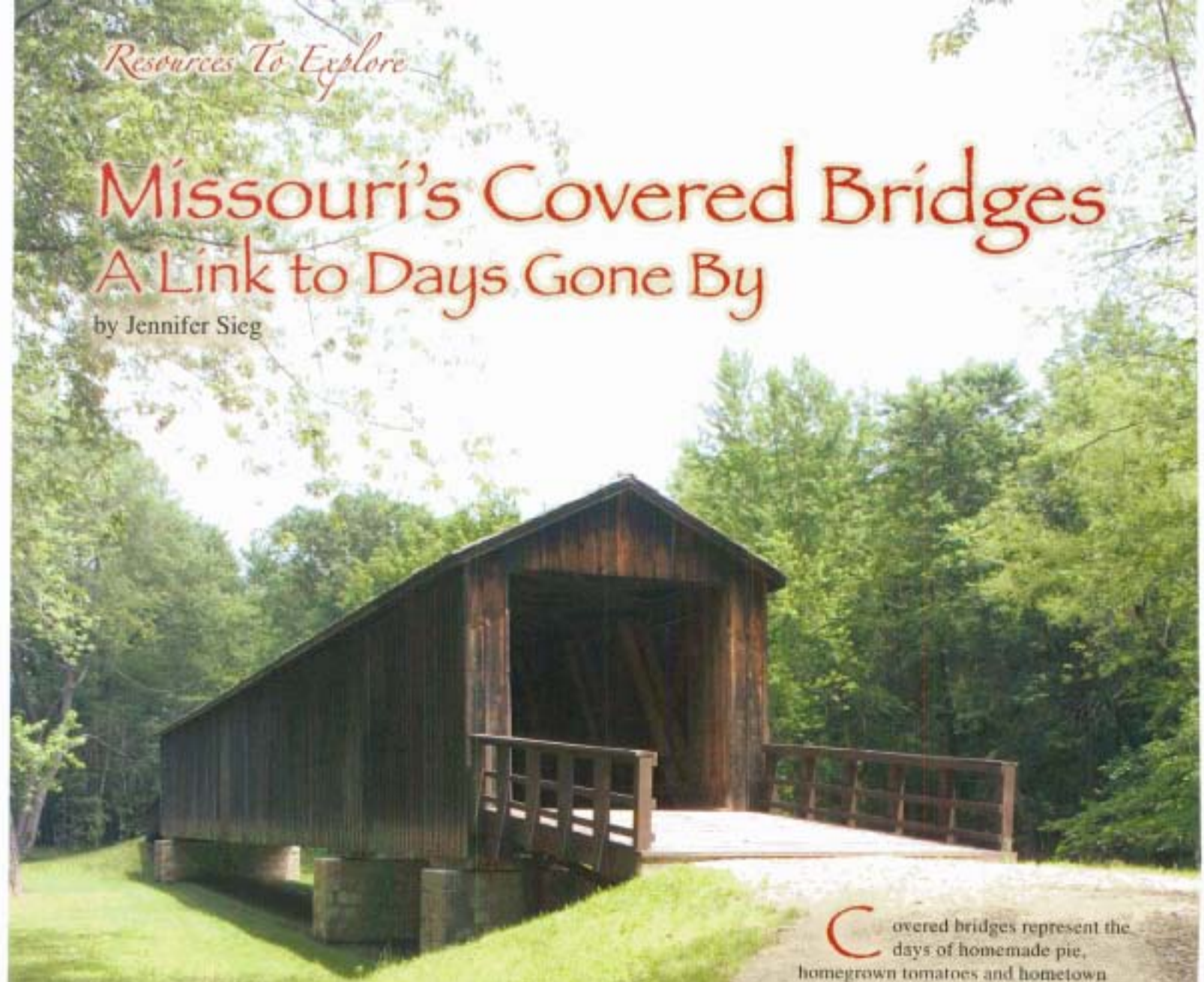
Bradford noted that the effects of the pollution were immediate. "The sludge eventually hardened into a crust on the banks. After the pollution was stopped, the sediment and sludge were still there," he said. The post-spill cleanup consisted mostly of pressure washing the dried sludge from the creek banks. He said the creek definitely looks cleaner but he still monitors the aquatic life, paying particular attention to one of his favorites – frogs.

Bradford said his interest in the environment began when he was very young. His mom, Michelle, an active volunteer in several environmental efforts, often took him along on days where she worked at a local recycling center. Trips to his grandmother's farm nurtured his love of the outdoors. Soon, Scouting tied it all together for him with programs on the environment that emphasized personal responsibility and stewardship. An aspiring inventor, Michael's mom says he can fix anything and his creativity is boundless. Asked if a 14-year-old has time to give even a moment's thought to a future career, Bradford said, "Oh yes, I definitely do think about it. I think I'll be an engineer of some sort, probably electrical. I think I'd like to focus on product designs, probably also product improvement."

Boone Creek and its surroundings can testify, thankfully, that Michael Bradford's career has already started.

Missouri's Covered Bridges
A Link to Days Gone By

by Jennifer Sieg



Covered bridges represent the days of homemade pie, homegrown tomatoes and hometown picnics; a time when journeys down life's road, or any road, were traveled at a slower pace. The estimated 30 covered bridges that spanned Missouri's rivers and creeks from the 1820s to the end of the 19th century served not only as links across waterways, but as emergency shelters, places for early entrepreneurs to advertise, and hidden spots where a young couple could sneak a kiss.

Although the cover provided by the bridge was put to good use by uncovered buggies during a rain storm, the main reason communities began covering their bridges was to protect the intricate structural network of iron and timber trusses from the weather. It prevented freezing in the joints during the winter and rotting during the summer. The barn-like appearance of a covered bridge also made it easier for farm animals to cross the river without becoming nervous.

As time went on, covered bridges were washed out by floods or were replaced by metal bridges, which could carry a heavier load. By 1967, when the Missouri Legislature passed a bill authorizing the Missouri State Park Board to take possession of, repair and preserve the state's remaining original covered bridges, only five remained. Before ownership could be transferred, the Mexico covered bridge washed away in a flood, leaving only four. Missouri's

surviving covered bridges are precious examples of fine craftsmanship using simple but effective engineering techniques.

Today, the Missouri Department of Natural Resources preserves and maintains these four surviving covered bridges, which are all in the National Register of Historic Places. Each has its own story and style.

Burfordville Covered Bridge, Burfordville

Missouri's oldest covered bridge, Burfordville Covered Bridge is part of Bollinger Mill State Historic Site. The side-by-side historic structures provide an excellent setting for artists, photographers or anyone wishing to relax and ponder life at a slower pace.

Joseph Lansmon began construction on the bridge in 1858, but it is unclear if the bridge was completed before or after the Civil War. The bridge exhibits Howe-truss construction, named after William Howe, who patented the design in 1840. Spanning the Whitewater River, the bridge is 140 feet long and was part of a toll-road system between Burfordville, Jackson and Cape Girardeau. It was a vital link for farmers destined for the mill.

Today, the bridge that once carried wagonloads of grain to the mill is open to pedestrian traffic only.

Directions: In Cape Girardeau County, turn off Highway 34 onto Highway OO. Take Highway HH to the site.

Locust Creek Covered Bridge State Historic Site, Laclede

Built in 1868 using the Howe-truss design, Locust Creek Covered Bridge is the longest of the remaining covered bridges at 151 feet.

This bridge not only reminds us of how lifestyles have changed, but also of how traveled highways and creek channels can change. It once housed America's first transcontinental road, Route 8, crossing over Locust Creek. Just as horse-drawn

(Opposite page) Locust Creek Covered Bridge, which once housed a transcontinental road, now spans a dry creek bed. (Below) The red barnlike appearance of Sandy Creek Covered Bridge provides a scenic setting for artists and photographers.

DNR photos, opposite page and left, by Scott Myers.

1 – Burfordville Covered Bridge, Bollinger Mill SHS, Burfordville
2 – Locust Creek Covered Bridge SHS, Laclede
3 – Sandy Creek Covered Bridge SHS, Hillsboro
4 – Unlon Covered Bridge SHS, Paris

DNR photo by Scott Myers

(Above) Justene and David Miller of Hazelwood wade in the Elk Fork of the Salt River below Union Covered Bridge. This historic bridge served travelers in Monroe County for 99 years. (Below) The side-by-side historic structures at Bollinger Mill State Historic Site, which were once bustling with activity, now provide a scenic, relaxing setting for a picnic lunch.

wagons and buggies were replaced with cars, in 1930, U.S. Highway 36 replaced Route 8. Today the road across the bridge is not the only thing missing. After World War II, most of Locust Creek's channel was straightened leaving the bridge spanning an empty creek bed.

Over the years, the creek bed filled with soil leaving the bridge resting on the ground. In 1991, the bridge was raised six feet to give it, once again, the appearance of a bridge and to protect the floor from the wet ground. The most recent restoration was completed in 2003.

Directions: In Linn County, go three miles west of Laclede on U.S. Highway 36, one mile north on Danube Drive (gravel road), and right on Dart Road.

Sandy Creek Covered Bridge State Historic Site, Hillsboro

John H. Morse constructed Sandy Creek Covered Bridge in 1872. The 74.5-foot-long bridge, also built using the Howe-truss design, was one of six covered bridges built on the Hillsboro and Lemay Ferry gravel road connecting the county seat of Hillsboro to St. Louis. The spring flood of 1886 destroyed the bridge, but it was rebuilt later that year.

Today, the bridge is open only to pedestrian traffic. After taking a stroll across the bridge, visitors can enjoy a picnic lunch in the shaded picnic area. The red, barn-like appearance of the bridge and the natural setting surrounding it make it an ideal scene for photographs and paintings.

Directions: In Jefferson County, go five miles north of Hillsboro on Highway 21, east on Goldman and southwest on Lemay Ferry.

Union Covered Bridge State Historic Site, Paris

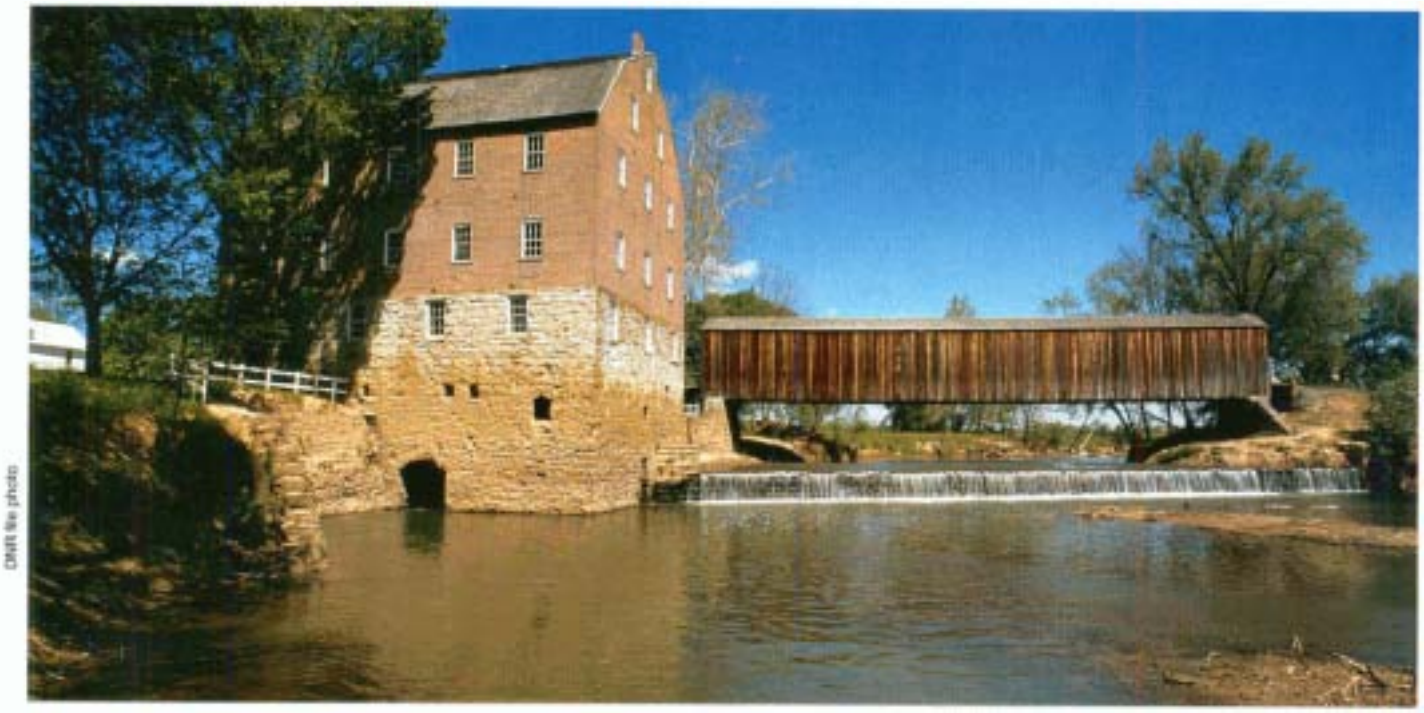
Union Covered Bridge, named after the nearby Union Church, is the only covered bridge left in Missouri representing the Burr-arch truss system. Joseph C. Elliot built it in 1871 using timbers fashioned from local oak and fastened together largely with treenails. The bridge, which is 120 feet long, was built to replace two uncovered bridges over the Elk Fork of the Salt River on the Paris-to-Fayette road.

After 99 years serving travelers in Monroe County, it was closed to all but pedestrian traffic in 1970, However, it remains an important structure in the area's history.

Directions: In Monroe County, take U.S. Highway 24 five miles west of Paris, then go three miles south on Highway C and .25-mile west on a county road.

For more information about these nostalgic reminders of days gone by, contact the Department of Natural Resources toll-free at 1-800-334-6946 (voice) or 1-800-379-2419 (Telecommunications Device for the Deaf) or visit the Web at [www.mostateparks.com].

Jennifer Sieg is a public information specialist for the department's Division of State Parks.



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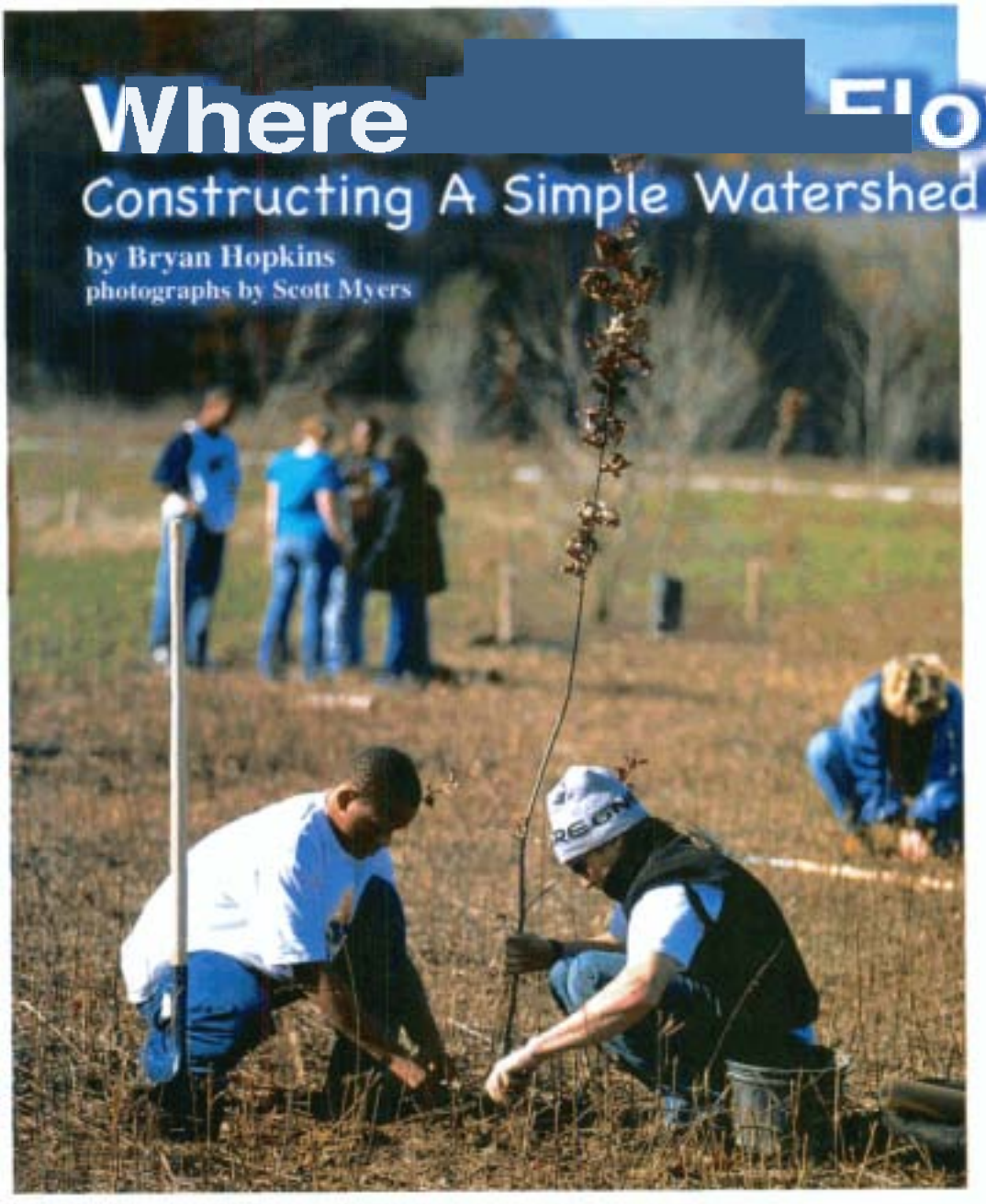
Where [redacted] Flow?

Constructing A Simple Watershed Model

by Bryan Hopkins
photographs by Scott Myers



One of the most important natural resources in the state of Missouri is safe, good-quality drinking water, and most students are surprised to know that their drinking water comes from the same watershed that receives their wastewater.

A watershed is an area of land that drains into a single river or body of water, and the quality of our drinking water is directly connected to the actions we take on a daily basis within our watershed. Every stream, river or body of water is a product of its watershed and is affected by events that occur within it.

We can divide water pollution into two main categories. One is point source pollution, which is characterized by an obvious entry point, such as chemical spills, discharge pipes from wastewater treatment plants or leaking underground storage tanks. Nonpoint source pollution does not have an easily defined source and results from a variety of entry points over a large area. Those include pesticide and fertilizer runoff from farms and urban homes, soil erosion from construction sites, and paints, oil, grease and gasoline released to street storm sewers.

Chad Pregracke of Living Lands and Waters and students from Hickman High School in Columbia plant pin oak trees in the Missouri River floodplain. The daylong workshop, sponsored by the Department of Natural Resources, provided firsthand experience in watershed rehabilitation at the Big Muddy National Fish and Wildlife Refuge.

Materials for Watershed Model

- Plastic spray bottle
- Large aluminum baking pan or plastic tub (16" x 11"; 2/3-inch deep)
- Large (18-inch wide) sheet of aluminum foil
- Five to six partially crumpled soda cans
- Masking tape
- Thin sponge (red or yellow for visibility)
- Scissors
- Food coloring (yellow, blue, red)
- Cup of fine soil or cocoa powder
- Newspaper or paper towels
- Pushpins or thumbtacks

Many of the nation's leading causes of water quality problems are the result of nonpoint source pollution. A simple and effective way to reduce such pollutants is to promote riparian zones and wetland systems. Riparian zones are areas of vegetation along river and stream banks. Wetlands are areas covered by shallow water or have waterlogged soils for all or a portion of the year. These include bogs, marshes, swamps, fens and prairie potholes. Both systems work by slowing down the flow of water, reducing erosion and filtering out sediments and chemicals from runoff. They also provide wildlife habitat.

Creating the Watershed Model

Break the class into groups of 3-4 students and give each group a large aluminum baking pan or tub. Instruct the students to tape together a pile of partially crumpled soda cans in the center of the pan and then gently mold a continuous sheet of aluminum foil over the cans and the bottom areas of the pan. The goal is to create a model with several hills and gently sloping sides. It is important not to teat the foil as it is molded over the cans.

Give each group a spray bottle filled with yellow food coloring (adjusted to "mist" setting). The students should gently "rain" on their watershed model and observe where the water flows and the resulting lakes and streams that form. Have the students draw a diagram of their watershed, indicating lakes, rivers and streams that form, as well as the location of major population centers within their watershed.

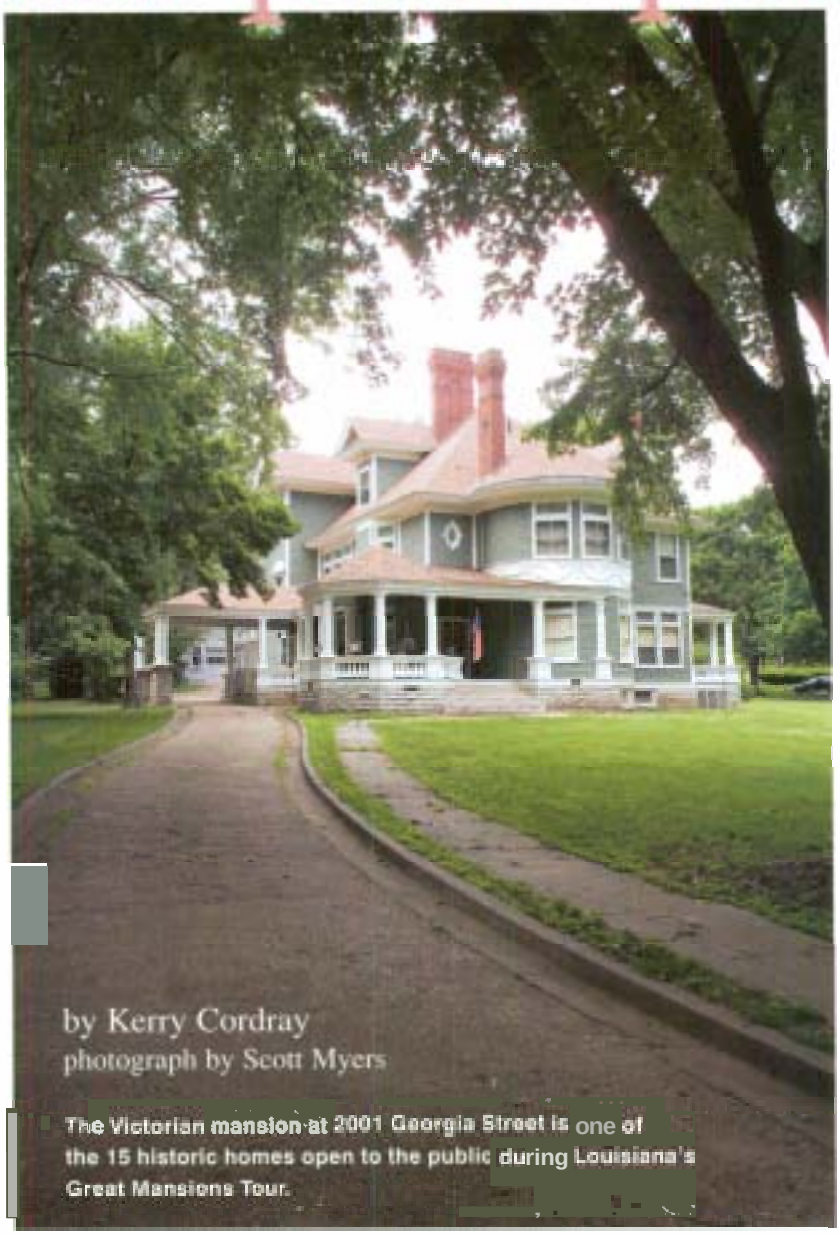
Now the students should begin to alter the watershed model and observe the results. Adding small strips of sponge can represent wetlands and groundwater systems. A drop of blue food coloring applied to a sponge near the top of the model will do a nice job of demonstrating point source pollution. Sprinkling cocoa powder over the watershed can indicate nonpoint source pollution. Strips of paper towel can represent riparian zones and small holes can even be punched in the model to emulate the transition of surface water to groundwater.

Encourage students to consider which locations within the watershed are impacted, and how communities might be affected. What are the sources of drinking water for each community? Give each group a pushpin or thumbtack and ask them to pick a site where they would build a home on the model. Why did they choose that site? At this point, it can be very powerful to provide the students with topographic or aerial map of your local region. Ask them look at their community from a watershed perspective. Such maps are available from the Missouri Department of Natural Resources or can be obtained free on the following Web site: [http:/lterraserver.microsoft.com/].

This exercise has proved to be a fun, easy and inexpensive way to help your class understand watersheds. It also clearly illustrates the often forgotten message – we all live downstream!

Bryan Hopkins is an environmental education specialist with the department's Outreach and Assistance Center.

Louisiana Tour of Treasures



by Kerry Cordray
photograph by Scott Myers

The Victorian mansion at 2001 Georgia Street is one of the 15 historic homes open to the public during Louisiana's Great Mansions Tour.

Among the state's many special historic resources, one of its most striking collections of antebellum homes is nestled in the charming town of Louisiana, Mo. The city's exceptional architectural heritage and unspoiled views along a stretch of the Mississippi River make it an irresistible stop along Route 79, the beautiful Great River Road National Scenic Byway.

In 2003, this city of 3,800 took giant steps to preserve its legacy by creating new residential historic districts and completing requirements essential to be recognized by the Department of Natural Resources' State Historic Preservation Office as a Certified Local Government.

"It is really the beauty of the river in this vicinity and the rolling terrain that makes this town special," said Tim Conley, president of the Louisiana Historic Preservation Association. "The huge collection of Federal and Greek Revival architecture at reasonable prices coupled with these natural attributes makes Louisiana a preservationist's dream." Conley also currently serves as chair of the Missouri Advisory Council on Historic Preservation.

On the second weekend in October, residents of the city's historic districts will sponsor a tour of some of their historic landmarks. Conley hopes the tour will help raise funds to write a nomination to place 16 blocks of historic Georgia Street on the National Register of Historic Places. The Great Mansions Tour will be held Oct. 9 and 10, from 11 a.m. to 4 p.m. Visitors will have a unique opportunity to view 15 of Louisiana's finest Federal and early Victorian style private family mansions, most of which have never been available for public tour.

A Decorator Showcase Home, furnished by a local antique mall, features oil paintings, oriental carpets and period antiques, and will be a major tour feature. Another highlight will be the town's original stagecoach stop, a Federal-style brick structure that currently serves as a Louisiana artist's studio. Local tradition holds that another property on the tour served as a station on the Underground Railroad before the Civil War. Professional storytellers will be on hand to recount the experiences of African-American slaves and their journeys to freedom.

Tickets cost $15 and will admit visitors to the 15 historic homes, an art exhibit, the Decorator Showcase Home and lectures and storytelling at the town's Masonic Temple ballroom. For more information, contact the Louisiana Visitors and Convention Bureau toll-free at 1-888-642-3800, or visit their Web site at [www.louisiana-mo.com].

Louisiana is at the junction of U.S. Highway 54 and Missouri Highway 79 in Pike County, 11 miles northeast of Bowling Green.

Kerry Cordray is division information officer for the department's Outreach and Assistance Center.

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